DOCUMENT RESUME

ED 029 373 EA 002 156

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Simulation in the Training of R & D Project Managers.

Ohio State Univ., Columbus. Educational Program Management Center.
Pub Date 8 Feb 69
Note-20p.; Paper presented at the Annual Meeting of the Amer. Educ. Res. Assn. (Los Angeles, Calif., Feb. 8, 1969)
EDRS Price MF-$0.25 HC-$1.10
Descriptors-Administrative Personnel, *Decision Making, Educational Research, *Management Education, Management Games, *Research and Development Centers, *Research Directors, *Simulation

Simulation is defined as a training exercise for administrators to develop decision-making skills in applying management processes and concepts in the areas of educational program and project management. A simulation exercise, comprising about half of a 1-week training program, was tested with almost 200 participants over a period of 15 months. Basic planning and programing features of the training seminars are outlined and the format of the individual sessions is described. Tabulated responses of 138 seminar participants to a 10-item evaluation questionnaire indicated an overall positive reaction toward the use of simulation in the training program. (JK)

ED029373

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Presented at the meeting of the American Educational Research Association, Los Angeles, California, February 8, 1969.

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EA 002 156

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SIMULATION IN THE TRAINING OF R & D PROJECT MANAGERS

by

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I. THE PROBLEM

For the past two and one-half years the staff of the Educational Program Management Center at The Ohio State University has been involved with the training of R & D program and project managers. As a part of the training program, there has always been some attention to the application of the techniques emphasized in the training program in order to see the degree of understanding of the concepts, techniques, and abilities of the participants. This application has taken the form of relatively simple practical exercises.

During the first series of four one-week training programs sponsored by the Research Training Branch at USOE and the 1967 AERA Presession, both undertaken by the Educational Program Management Center, the practical exercise used was one which the director of the Center developed primarily as an output of the PERT Project (1). This exercise is considered to be "canned" in that it was highly structured in its approach, did not allow for much freedom, and was too narrow in content since it was based on a survey of an hypothetical parking problem at a university. In addition, an evaluation of the above mentioned training program raised some question about the relevancy of the exercise problem to the situations encountered by many educational researchers.

The authors wish to express their appreciation to John Church, Research Assistant, for his help with data analysis.

Out of this need for a more realistic and broader based exercise came the decision to develop an exercise using the technique of simulation. It was felt that increased realism and greater involvement by participants would be obtained by the use of a simulated situation which demanded more complex skills, some degree of role playing, and increased opportunity for decision making in various education related management positions.

During the past sixteen months, the staff of the EPMC has been involved in the development and testing of a simulation exercise which is designed to meet these needs. This paper describes the development and use of this exercise in relation to the training of R & D project managers. Before describing the development of the simulation, perhaps a brief definition of both nature of project management and simulation is important to set the context.

PROJECT MANAGEMENT

Projects are found in almost all existing educational organizations today as well as in every business, industry, and governmental level. They are "unique, well-defined efforts to produce certain specified results at a particular point in time, and typically cut across many functional and organizational lines (2)."

Project management began in the 1950's with the Navy Polaris Program which was "a complex program consisting of the development and production of the warhead, the missile launcher, and the submarine carrier through prime and sub-contractor structure (3)." The use of project management tools of the Program Evaluation and Review Technique (PERT), system analysis

and similar applications have been credited with bringing the Polaris project to fruition a full two years ahead of schedule. As a result of such success, project management emerged as an integral management force throughout DOD, NASA, and the aerospace industry, as well as having literally hundreds of applications in business and industry in this country and abroad. Applications have been made of project management to non-defense and non-technological situations at a much slower pace. Applications to education and the social systems, however, have received some attention in recent years (4).

Important to our consideration here is the question, "Can training in project management techniques provide educational project managers with the tools to implement some valuable project earlier and thereby have an untold positive effect on educational practices?" Hope for even a modest improvement has led to the development of the Educational Program Management Center, which intends to undertake research, development, and training in the application of management techniques to education.

SIMULATION

The first modern use of simulation was the development of the business game by the American Management Association in 1956, although the study and considerations given military war games as a basis for this is well documented (5). Since that time the developments in simulation have been extremely rapid and varied as the result of the influence of electronic computers, the development of the theory of games in operations research, and the spread of simulation to almost every discipline. The importance of

simulation in educational research and research related areas is seen by the formation of such groups as a Special Interest Group in AERA concerned with instructional simulation. Leaders in this movement include Donald Cruickshank (6) as Chairman and Paul Twelker (7) as secretary. The growth of this group to over 40 persons from February through October of 1968 indicates the interest of research-oriented educators in simulation. The range of definitions and uses of simulation extends from computerized mathematical modeling to election forecasts, from space flight simulation and training of pilots and astronauts to in-basket techniques for training school administrators (8). As used in this study simulation refers to a decision-making exercise used as part of a training program in understanding and applying a relatively large number of management processes and concepts important in the areas of educational program and project management.

II. DEVELOPMENT AND USE OF SIMULATION MATERIALS

The need for a broader based exercise, particularly for use in conjunction with the training activities of the Educational Program Management Center, was established earlier in the paper. Following the decision to use simulation as an attempt to fill that need, a study of simulation was undertaken. It was found that even with the availability of an excess of a thousand references on the topic of simulation, very little of the literature presented practical techniques or guidelines which could be employed in the design of a simulation exercise (9). Consequently, the authors had to proceed largely on the basis of their own experience and that of others who had been involved in actual simulation exercises.

The initial decisions regarding the design and development of the simulation materials include the following items:

(1) The materials would first be used to train educational researchers or those dealing with research and should therefore involve one or more problems or projects with which such people might be familiar.

(2) Although the immediate problem would probably deal with the management of research (a specific project with a relatively narrow focus), the simulation should build toward program management (several or a large number of projects with broad implications and focus).

(3) The scenario should be built around one of three familiar educational settings: a university setting, a regional laboratory/R & D Center/State Department setting, or a public school setting. The decision was made that a setting which might combine a regional laboratory and an R & D Center with emphasis on the former would be used for the development of the materials.

(4) In connection with the above selected scenario, the following items would have to be included or dealt with: the organizational structure including sub-units, the statistical and duplicational limitations of the setting, the varied personnel and the background of the organization.

(5) The simulation exercise would permit and require application of the following concepts which were treated by previous staff presentations: project definition, networking, scheduling; resource allocation problems, updating, and problem identification.

(6) The consideration of the specific problem/project to be used in the materials was narrowed down to those with which the staff designing the simulation exercise were familiar. They included computer assisted instruction, development of non-graded school, the management of a recently approved proposal, or the response to a "request for proposal" (RFP) from a Federal agency. The latter of these four was ultimately chosen as the one which would be used.

(7) It was further decided that the following items needed to be developed: a statement of program focus; a statement on the history of the hypothetical organization; a description of the organization or organizational chart; a statement regarding the number, size, and qualifications of the staff; a description of available facilities; statements of relationship to USOE, state departments of education, universities and colleges, R & D centers, and public schools.

(8) The participants were to produce a work breakdown structure and network which was to be scheduled and later replanned for the same project.

(9) The project was to be of their own choosing in response to the RFP. They were to be working in a simulated hypothetical organization in groups which require some role-playing.

Figure 1 gives a description of the inputs given to the participants under the three major topics and the expected outputs for the initial simulation exercise.

It can be seen from Figure 1 that the original simulation exercise was designed to take place in three sessions. Each of these was to require about one-half day of the second, third, and fourth days of a five day training session. From the inputs which the participants received, they were required to spend the first session analyzing the materials and defining the project in a proposed response to the RFP. For this to be accomplished successfully the participants had to assume that they were part of the organization which was responding to this RFP and make a relatively large number of decisions involving a number of complex management functions. These included: communications to the point of agreement and action; selection of appropriate information from among that which was given; identification of major goals and a hierarchical breakdown of the functions, products, and work to be done; arrangement of the defined tasks or activities into a sequentially ordered network showing interrelationships. The complexities of these management problems were such that this was not accomplished in one session; therefore they

FIGURE 1 - Development Steps for Simulation Exerices

Session	Topic	Simulation Inputs	Simulation Outputs
First	Project Definition and Planning	1. RFP plus work statement (dated) 2. Press Release 3. Appointment memo (dated) - includes appointment of project director plus 4 staff members from divisions of Center by name; contains recommendation by Board of Trustees to respond to RFP 4. Minutes memo (dated) - includes results of first meeting outlining scope and sequence of work in sufficient detail that participants could develop workbreakdown structure and network. Includes comment dealing with development of WBS and network at next meeting 5. Task assignment memo - time now statement outlining what is to be accomplished during the three hour time period. Roles to be assigned, calendar as needed, etc.	1. Workbreakdown structure and network
Second	Time estimating, scheduling, resource allocation, and budget preparation	6. Task assignment memo - project director saying that agreement was reached at last meeting to do the time estimating, scheduling, resource allocation, and gross budget preparation at this meeting	2. Planned schedule for project 3. Gross budget for project

FIGURE 1 - Development Steps for Simulation Exercise (Continued)

Session	Topic	Simulation Inputs	Simulation Outputs
		7. Budget worksheet 8. Budget Summary 9. Board presentation memo - requests that project director and staff make a presentation to the Board of Trustees	
Third	Control/Decision Making	10. Control memo - notes approval of project and carries project into a time period of operation. Situation is described which has delayed the project by several weeks. Problem is not correctable so participants will have to suggest recommendations to project director regarding alternative procedures which will get the project back on schedule with no additional cost.	4. List of recommendations or alternative solutions to project director

were really completed during the second simulation session. As the simulation materials were revised over the past year (they have been used in seven training programs, and we presently have data for six of these programs) we have alloted more total time but in shorter sessions to the simulation activities. At present, the simulation constitutes about half of the total training time.

As can be seen from Figure 1, the topics for the second and third sessions were involved with other management planning and control functions and required different inputs and outputs. Although these will not be discussed here, it should be noted that success in these sessions depended upon the efforts and success in achieving the product for the first session, and sessions two and three were based on these previous efforts.

During the simulation process the participants were seated at work tables in groups of from four to six. Each group represented middle level management positions in a separate non-competing hypothetical organization resembling a regional laboratory. The chairman of the group was arbitrarily assigned so as to facilitate quicker organization and action of the group. As work progressed, the additional input was given to the participants. This input, usually given in the form of a memorandum, required additional management decisions and other functions typical of an R & D project manager.

After about 8-9 hours of the simulation process, a board of trustees meeting of the organization was called at which time each group summarized its plan, problems, and work accomplished. This provided a vehicle for a group summary of management problems, difficulties of operation, and experience in presentation of a proposal to a top level management group.

At the end of the training program the participants were asked evaluate the simulation exercise as a part of the total program.

III. EVALUATION OF SIMULATION MATERIALS AND USE

Evaluation of the simulation materials was provided by a form using ten open-ended questions (See appendix #1). The purpose for obtaining this type of feedback was to provide information and suggestions for improving the simulation materials. Minor differences were made in the use and/or content of the exercise as the development of the materials continued. For example, on the basis of the first session where the simulation was used, it was determined that the RFP was too complex and obtuse for analysis in the available time. Therefore, another RFP was used and found more adaptable to the simulation objectives.

The evaluation form was basically the same for five of the six training sessions in which the simulation was used. For these five training sessions the open-end responses were examined and classified in one of seven ways. If the response was totally positive by such comments as "very good," "good," "well done," or some phrase which was obviously positive in nature, it was rated as positive. In similar manner, if the comment was negative in tone by such comment as "poor," "inadequate," or a phrase such as "little feedback," "not enough time," etc., the response was rated as negative. If the comment written involved both positive and negative statements, or was of an indeterminate nature such as "ok," "adequate," or "fair" it was rated as neutral, unless in the context of the participant's paper, that comment was probably either positively or negatively intended.

A reaction was rated as suggestion if the participant made a suggestion without giving a value judgement to it. If however, a suggestion was made after a comment such as "fine but could have . . . " or "poorly done, but could be improved by . . ." then the reaction was rated either positive-plus suggestion or negative-plus suggestion. Finally, if the item was left blank on the evaluation sheet, the rating of no-response was given.

Table I lists the reactions obtained for the open-end evaluation form for the session. It should be noted that such a rating of reactions for questions dealing with suggestions for improvement and other general comments may have little meaning. Because of a change in the form itself after it was used two times, there is no data provided for question 10 for two training sessions, the AERA Presession and session number 1. On the basis of the data presented in Table I, the following comments can be made.

(1) The most positive reactions were toward the realism of the simulation exercise (item 2) and the correlation of the simulation sessions with their preceding instructional sessions (item 5). The third and fourth most positive parts were the administration and organization of the simulation exercise (item 1) and the information contained in the materials (item 4).

(2) The most negative reactions were to the time length for each session (item 3) (over 1/3 of these came from the AERA Presession), the explication of the roles to be played and the value of role playing (item 6), and the feedback from the staff (item 7).

(3) The item which had an approximately equal positive and negative reaction referred to the clarity of the end products (item 8). It is suggested that these responses might have been different if the question were changed so that it referred to either the clarity seen before the work was undertaken or the clarity of the products achieved at the end of each session.

(4) The largest number of neutral responses were obtained on the items concerning the time length of each session (item 3), the information in the materials (item 4) and the clarity of the end product (item 8).

(5) The largest number of non-value-laden suggestions were given in response to the items asking for suggestions for improvement (item 9), as would be expected, and followed by the items referring to administration and organization (item 1) and feedback from the staff (item 7).

For the sixth session, the workshop coordinator constructed a semantic differential scale consisting of six concepts, with ten pairs of terms relating to each concept. One of these concepts was "simulation activities." On this scale there were no negative ratings, an average of one neutral rating per pair, and an average of seventeen persons rating the item positively. These positive ratings were about equally split between the most positive response and the most neutral response.

On a separate critique form an item asked which features of the training program (or workshop) "were especially facilitative to (learning)". The responses by 18 participants showed the simulation to have the strongest

TABLE I - Summary Rating of Participant Reaction to Materials and Use of Simulation Exercise

ITEM	RESPONSE CATEGORY						
	N	Positive & Suggestive	Positive	Neutral or Suggestion	Negative & Suggestion	Negative	No Response
1. Administration & Organization of the Game	138	9	32	67	6	13	11
2. Realism of the Game	138	9	60	44	2	10	13
3. Time length for each session of the Game	138	7	13	65	7	39	7
4. Information contained in Organization Description & Action Memorandums	138	5	28	64	5	20	16
5. Correlation with Instructional Sessions preceding Game Play	138	3	61	42	1	13	18
6. Explication of Rules to be Played - Value of Role Playing	138	12	19	51	7	33	16
7. Feedback from the Staff	138	3	18	64	15	24	14
8. Clarity of End Products to come out of each Session	138	0	33	53	3	31	18
9. How can the Game be Improved?	138	4	2	90	11	4	27
10. Other or General Comments	77	4	17	12	2	4	38

effect (N=12), followed by parts of the lectures (N=5) and visuals (N=1).

Therefore it can be seen that the participant evaluation of the simulation was very positive, with no negative reaction for this particular workshop. However, it could be argued that if the same open-ended form had been used, the responses would have included suggestions for improvement and, by implication, at least some negative responses.

SUMMARY

The purpose of this paper was to present a discussion of the development and use of simulation in the training of R & D project managers.

The need for a realistic, broad-based exercise to train R & D project and program managers in education led to the exploratory development and use of a simulation exercise. This exercise, now comprising about half of a one-week training program, was designed and tested over the past 15 months with almost 200 participants.

A summary of the decisions made regarding the design, development, and use of the simulation materials was presented. This was followed by a discussion of the open-ended evaluation form used for five of the seven training programs where the simulation has been used. Useable feedback from 138 participants was rated in one of seven ways as a basis for a general evaluation of the instrument. An additional 18 participants provided an evaluation by means of a semantic differential scale.

The evaluations showed overall positive reactions toward the use of simulation in the training program. The problems of the time length of the simulation sessions; of the place and amount of role playing; and the amount and appropriateness of feedback are currently the subject of further study. Much more developmental and experimental work needs to be done. At this time, however, it can be said that simulation appears to be a very promising tool in the training of R & D project managers.

APPENDIX #1

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MANAGEMENT GAME EVALUATION

The SWINDLE-SIS management game in which you participated is in the process of being developed as a management instructional device. In order to revise the game, we would like to have your comments and suggestions regarding the several points listed below. Use the reverse side to make any more general comments or suggestions you might have.

1. Administration and organization of the game:

2. Realism of the game:

3. Time length for each session of the game:

4. Information contained in organization description and action memorandums:

5. Correlation with instructional sessions preceding game play:

6. Explication of roles to be played. Is it realistic to attempt to play roles? If not, could anything be substituted to require adaptation to the context of the situation?

7. Feedback from staff regarding your group's actions during sessions or at end of sessions. Suggestions as to how this could be improved:

8. Clarity of end products to come out of each session:

9. How could the game be improved? (Use reverse side as needed):

10. Other or general comments:

6/25/68

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Cook, Desmond L., principle investigator of reference number one (above) and several more recent books and papers, especially "Better Project Planning and Control Through the Use of System Analysis and Management Techniques." Paper presented at the Symposium on Operations Analysis of Education, U. S. Office of Education, Washington, D. C., November 20-22, 1967.

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